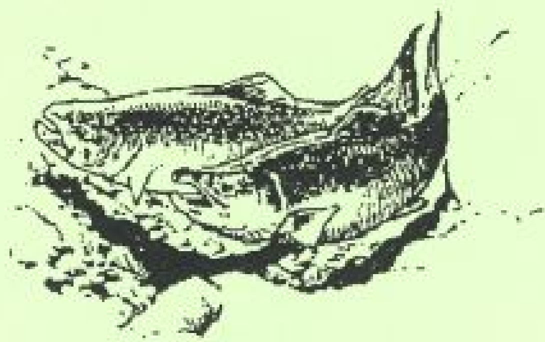
UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Estimated Influences of Feather Edge and Side-channel Projects on Water Temperatures of the Upper Trinity River



REGION ONE

December 1994

Estimated Influences of Feather Edge and Side-channel Projects on Water Temperatures of the Upper Trinity River

Prepared by:

Paul A. Zedonis

December, 1994

Trinity River Flow Evaluation
U.S. Fish and Wildlife Service
P.O.Box 630
Lewiston, California 96052
(916) 778-3536

ACKNOWLEDGMENTS

Funding for this analysis was provided by the Bureau of Reclamation as part of the Trinity River Flow Evaluation Study. In addition, I would like to thank Chuck Lane, Mark Hampton, Ian Gilroy from the Weaverville U. S. Fish and Wildlife Service Restoration Office, Jeff Thomas of the Fish and Wildlife Service, and John Bartholow from the National Biological Survey for their comments.

TABLE OF CONTENTS

LIST OF TABLES

TABLE

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

INTRODUCTION

As part of the anadromous fish habitat restoration program for the Trinity River, an EIS is required before large-scale construction of feather edge and side-channel projects can proceed. These project are constructed to provide additional rearing and spawning habitat for anadromous salmonids of the Trinity River. An important element of the environmental document will be to understand the influences that these proposed projects will have on water temperatures of the mainstem Trinity River throughout the year.

An analysis of this type was conducted in 1992 by this office and the results of the preliminary modelling effort showed a 0.72°C (1.3 °F) increase in the mean daily temperature nearly 59.6 km (37 miles) downstream of Lewiston Dam under a worst case scenario. However, the model used for that analysis was the SSTEMP model (Stream Segment Temperature Model) rather than the more detailed SNTEMP model (Stream Network Temperature Model). SSTEMP is a scaled down version of SNTEMP. Being a simplified model, SSTEMP did not allow for available detailed information regarding the restoration projects, including locations and changes in stream width and shading, to be incorporated into the analysis. This report describes the results of several model runs for baseline and full project implementation conditions using SNTEMP.

SNTEMP MODEL DESCRIPTION

The SNTEMP model has been used in a variety of applications including analysis of streamflow versus water temperature relationships below dams under various release patterns and the effects of riparian vegetation removal (Theurer *et al.*, 1984). It consists of several programs which are used to predict water temperatures under a variety of meteorological and hydrological conditions. More detailed information about SNTEMP is contained in Instream Flow Information Paper No. 16 (Theurer *et al.*, 1984).

In SNTEMP, the Trinity River is represented by several nodes which are used to describe different attributes of locations in the stream network (Figure 1). For a list of what these nodes represent, again refer to Theurer *et al.* (1984). Among all of the node types, the only one which had relevance to this analysis was the change node (C-node). A C-node represents a segment boundary where a change in stream geometry or shading is apparent. Changes in stream geometry include stream orientation (azimuth), stream width, and/or the width to discharge relationship. This model contains 35 C-nodes in the 59.6 km study area.

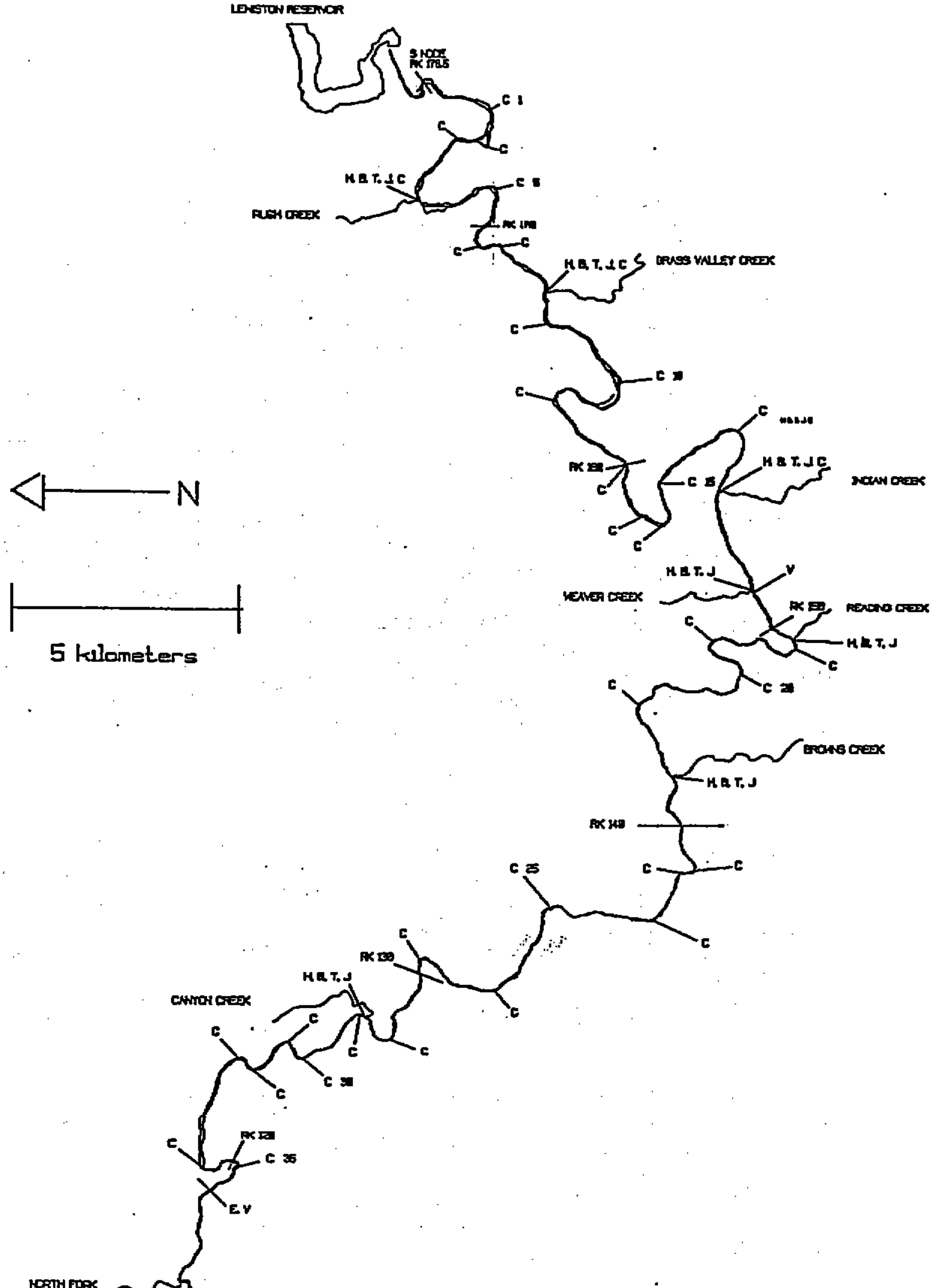


Figure 1. Stream geometry network

The Trinity River temperature model is based on a weekly time-step and has been calibrated with three years of data. The model was set up such that hypothetical year (hot-dry, median, and cold-wet) simulations could be made using historic meteorologic and hydrologic data sets for "what if" type questions. Hypothetical years were constructed with weekly exceedance criteria rather than being based on an entire year. This method of determining a year type can be thought of as extreme in that one would not expect to find a year containing 52 consecutive weeks of hot-dry, median, or cold-wet conditions. Thus, the modeling results are not useful for analyzing a year as a whole, but are useful for investigating the effects during independent weeks of a year.

A hot-dry year was represented by exceedance values of 10 percent for air temperature and percent possible sunshine, 50 percent for wind speed, 90 percent for relative humidity, and 90 percent for tributary hydrology. A median year was represented by exceedance values of 50 percent for all parameters. A cold-wet year was represented by exceedance values of 90 percent for air temperature and percent possible sunshine, 50 percent wind speed, and 10 percent for tributary hydrology. Stated another way, the hot-dry and cold wet year types would occur about once in 10 years, and the median year would recur about every other year.

FISH HABITAT RESTORATION PROJECT DESCRIPTIONS

Along the upper 59.6 km of the mainstem Trinity River, between Lewiston Dam and its confluence with the North Fork Trinity River, Restoration Program personnel have selected 57 potential sites for feather edges and 6 potential sites for side-channels. Together these projects would result in modification of about 23.5 km of the rivers edge or about 19 percent of the upper river. There have been 18 pilot side-channel and 9 pilot feather edge projects constructed previously.

Feather edges are constructed mechanically by removing a portion of the bank berm which developed as a result of relatively stable low flows. These low flows allowed riparian vegetation to grow along the banks and sediment transported at periodic higher flows to deposit and form berms. Feather edge projects essentially remove this berm and the associated riparian vegetation to create a wider, shallower channel and a wider channel at varying flows (i.e., change the width to discharge relationship).

Side-channels are also mechanically constructed. This type of channel feature is created by bulldozing a channel of specified dimension adjacent and parallel to the main channel. Sites chosen for side-channel restoration projects are typically historic overflow channels. Side-channel creation results in an increased wetted width for the main channel. It was assumed that the influence of side-channel projects on riparian vegetation was minimal.

METHODS

Model Input Data Changes

Stream geometry and stream shading were the only two components of the input data files that were modified to reflect future stream conditions with full project implementation. Stream geometry variables which were modified included stream width and the width to discharge relationship in the stream geometry data file. Loss of riparian shading was taken into account by decreasing baseline shade file data.

Wetted Width

The average wetted width increase from construction of feather edge and side-channel projects was determined by averaging widths of existing pilot projects. In the case of the feather edge projects, the average width of nine pilot projects resulted in an increase in channel width of 8.2 meters. The average width of side-channels, 6.1 m, was determined by averaging the average widths of the twelve existing pilot projects.

In order to have these changes reflected in the segment containing the project(s), it was necessary to apportion the increase in stream width across the entire segment. For example, if the stream segment was 100 m in length and 50 m wide, and a feather edge was going to be constructed measuring 50 meters in length, the new wetted width, 54.10, would be calculated by the following equation

$$\frac{(50 * 58.2) + (50 * 50)}{100} = 54.10$$

New values were then substituted into the stream geometry file.

Width Discharge Relationship

It was assumed that only feather edge projects would result in a "fl`ttening" of the bank and consequently alter the width to discharge relationship of the project area. Existing side-channel banks exhibited "flattening" to a much smaller degree, and were not incorporated in the model.

Bank profiles taken before and after construction on established transects at four sites were used to determine the average change in bank slope for a feather edge project (34 %). This value was reduced by 50 percent (to 17%) to account for both sides of the River. The sites used to determine this value included Bucktail, Steelbridge, Deep Gulch, and Jim Smith.

In the stream geometry file of SNTEMP, the width to discharge relationship is represented by

$$W = A * Q^B$$

where,

W is known width
A is the width's A term (dimensionless)
Q is the known discharge
B is the slope, and
^ is exponentiation.

The effect of feathering the bank is an increase in the B variable. To determine this increase, an equation similar to that used in the Wetted Width section was applied

$$NSS = \frac{(PL * NPS) + (SL - PL) * ES}{SL}$$

where,

NSS is the new segment slope
NPS is the new project slope
PL is the project length
SL is the segment length,and
ES is the existing slope.

Shading

The SNTEMP model includes an input file containing shade data for both sides of the stream. This data was collected during the summer of 1992 using the methods prescribed in Bartholow (1989). East and west sides of the stream refers to the side of the stream with respect to due south or the azimuth.

Of the many variables contained in the shade file, only the maximum and minimum shade density were modified because of feather edge construction. Feather edge projects were assumed to remove 100% of the riparian vegetation. To determine the change in shade density of east and west sides of the river, the existing shade was weighted based on project and segment length using an equation similar to those used in the previous sections

$$NSD = \frac{((SL - PL) * ESD) + (PL * PSD)}{SL}$$

where,

NSD is the new shade density
SL is the segment length
PL is the project length
ESD is the existing shade density, and
PSD is the project shade density (always equal to 0.0).

In other words, the removal of the riparian vegetation for the project length of a river segment would be similar to thinning the entire side of the affected segment. Similar to the procedure used in the initial calibration of SNTEMP, minimum shading density was reduced to 25% of the maximum shading density.

Simulations

Separate files for model simulation runs were developed for a baseline condition and with full project completion reflecting the changes described above. The baseline condition was assumed to represent existing conditions including pilot projects, because these projects were already completed and incorporated into model calibration.

For each hypothetical year type, model simulations were performed with baseline and all project scenarios for the time periods of October 1, December 31, April 1, and July 1. The first and last dates correspond to times when water temperature objectives in the Trinity River are in affect at Douglas City and at the confluence with the North Fork Trinity River, respectively. The other dates were used to determine the effect all projects would have on water temperatures during winter and spring.

Assumptions made in the simulations were that release water temperatures from Lewiston Dam were 10°C, 6°C, 7°C, and 10°C for the respective dates of October 1, December 31, April 1, and July 1. These temperature values fell within the range represented by historical data. Simulations were run with a release of 300 cfs (8.5 cms) and 800 cfs (22.6 cms) from Lewiston Dam for all scenarios. The 800 cfs release was examined because travel time is an important component that influences water temperatures temporally and spatially, especially when cold water releases occur during the summer months or warm water is released during the winter months.

RESULTS

Physical Changes

Stream width of affected zones increased from 26 to 1.5 percent depending on the proportion of the segment being modified. Segment 32 had a 26 percent increase in wetted width (from 28 m to 37.9 m) as a result of 1128 meters of projects in a segment which was only 940 meters in length; this is possible since there are two sides of the river. Wetted width in Segment 17 also increased substantially at over 23 percent. Table 1 contains a list of the segments being considered for channel manipulation and the corresponding increases in wetted width from these projects. All tables are presented at the end of this report.

The width to discharge slope increase ranged from 17.6 to 1.1 percent in the affected segments. Segments 17 and 32 showed the greatest increase at 17.6 and 16.9 percent, respectively. Table 2 contains the expected change in the width to discharge relationship of all affected segments.

Vegetative shading losses were variable on the east and west sides of the Trinity River. Losses ranged from 6.53 to 71.38 percent on the east side of the Trinity River, and from 4.6 to 99.6 percent on the west side of the Trinity River. Table 3 contains a summary of shading losses for all affected segments.

Water Temperature Changes

Douglas City

Mean weekly temperatures of the Trinity River at Douglas City varied temporally, by hypothetical year type, and as a result of construction of all proposed projects. Results of the simulations for baseline conditions at a release of 300 cfs from Lewiston Dam are presented in Table 4a, while those for complete construction of all proposed projects are in Table 4b. Differences between with and without proposed projects are presented in Table 4c. Results from simulations at 800 cfs for baseline conditions are presented in Table 5a, while those containing with project conditions are presented in Table 5b. Differences between baseline and with full project conditions are presented in Table 5c.

Hot-dry year type. Model simulations preformed under this scenario resulted in the largest temperature change between with and without project conditions for simulations at 300 and 800 cfs. With flows at 300 cfs, the largest temperature increase occurred in July (0.16°C), followed by October (0.09°C), April (0.05°C) and December (0.01°C).

With the release from Lewiston dam at 800 cfs and a similar release temperature, simulations resulted in smaller differences between with and without project conditions in July (0.08°C), October (0.04°C), and April (0.03°C). No change occurred during the December time period.

Median year type. Simulations for this scenario indicated decreased temperature effects compared to the hot-dry year scenario for 300 and 800 cfs releases. At 300 cfs, the greatest change in temperature occurred in July (0.13°C), followed by October (0.09°C), and April (0.03°C). No change occurred during the December time period.

Similar to the hot-dry scenario, increasing flows to 800 cfs resulted in smaller changes in water temperatures compared to the 300 cfs simulations. Temperature changes were less than those values presented above for July (0.08°C) and October (0.04°C). The December and April time periods did not change.

Cold-wet year type. The cold-wet scenario resulted in the smallest temperature changes between with and without project conditions. At a release of 300 cfs, water temperatures increased 0.10°C in July, followed by 0.06°C in October, 0.01°C in April and no change in December.

Similar to the previous scenarios, a release of 800 cfs showed reduced temperature changes between with and without project conditions compared to the 300 cfs simulations. Average weekly water temperature increases were greatest during July (0.06°C), followed by October (0.04°C), and April (0.01°C). The December time period, as was the case in the other scenarios, showed no temperature increase.

Trinity Canyon Lodge

At this location, 59.6 km downstream of Lewiston Dam, water temperatures were influenced to a greater extent than at Douglas City. Results of the simulations for baseline conditions are presented in Table 6a, while those for complete construction of all proposed projects are located in Table 6b. Differences between with and without proposed projects are presented in Table 6c. Simulations at 800 cfs are presented in Table 7a for baseline conditions, Table 7b for full project implementation, and Table 7c for differences between with and without project conditions.

Hot-dry year type. The hot-dry scenario simulations resulted in the greatest change in average weekly temperatures between with and without project conditions for all three year type scenarios for 300 and 800 cfs releases from Lewiston Dam. With a release of 300 cfs, the greatest increase occurred in July (0.30°C), followed by October (0.18°C), April (0.09°C), and December (0.01°C).

In general, simulations at 800 cfs indicated reduced affects compared to the 300 cfs simulations. The largest change in temperature between with and without project conditions occurred in July (0.21°C), followed by October (0.11°C), April (0.07°C), and December (0.01°C).

Median year type. Resulting temperature changes for the median year simulations followed a similar temporal trend as the hot-dry scenario. With a 300 cfs release from Lewiston Dam, the largest change in water temperature between with and without project condhtions occurred during the July time period (0.25°C) followed by October (0.17°C), April (0.06°C), and December (0.01°C).

Increased flows also decreased the influences of increased width and decreased shading on water temperatures. Simulations at 800 cfs indicated that temperature changes were largest for July (0.18°C) followed by October (0.10°C), April (0.05°C), and December with no change.

Cold-wet year type. Results from the cold-wet year simulations showed a similar trend as the other scenarios but with smaller temperature changes. Simulations at 300 cfs indicated the greatest temperature change occurred during the July 1 time period (0.18°C), followed by October (0.10°C), April (0.02°C), and December with no change.

As with the previous scenarios, a release of 800 cfs from Lewiston Dam resulted in smaller changes to water temperature as compared to less volume (300 cfs). Water temperature changes were largest in July (0.14°C) followed by October (0.07°C), April (0.02°C), and December (-0.01°C).

DISCUSSION

Increased stream width, flattening of the stream banks, and decreased riparian shading would all influence the heating potential of the Trinity River. It appears, however, that their influence on water temperatures would be slight. This probably indicates that water temperatures in the Trinity River are relatively insensitive to these variables at current Lewiston Dam discharges. Wetted width of a stream can be a very sensitive variable as Bartholow (1989) points out. However, he mentions that the sensitivity of a variable may also be related to other variables. For example, he found that water temperature may be very sensitive to air temperature if certain conditions are present (i.e., flow is low, the stream is wide and shallow, relative humidity is high, and wind speed is high) and insensitive if these conditions are absent. This analysis showed that increased wetted width from project development would have more of an effect if stream flows are low.

The magnitude of flows released from Lewiston dam also influences temperatures, in part because stream width changes with discharge. However, at flows of 300 to about 800 cfs the width of the Trinity River changes little because the channel is trapezoidal with very steep banks. Therefore, the influence is minimal. At 800 cfs, travel time downriver is reduced and consequently water temperatures are moderated throughout the year. Flows outside this range (less than 300 cfs and greater than 800 cfs) would result in an increased width to depth ratio and increase the influence which meteorology has on water temperatures.

Decreased shading also influences water temperatures. Removing riparian vegetation increases the amount of solar radiation being intercepted by the water surface and substrate thereby increasing the water temperature. In all segments of the

Trinity River, topographic and riparian shading are influential on water temperatures. In some segments topographic shading is more dominant during late fall, winter, and spring. Topographic shading is important as it determines the local time for sunrise and sunset, while riparian shading is influential during the day only if it casts a shadow on the river (Theurer et al. 1984). Moore (1967) found that streams oriented east-west were warmer than north-south oriented streams. Burton and Likens (1973) and Meehan (1970) found heating in unshaded portions and cooling in shaded portions in several small low-discharge streams. Because the direction of the Trinity River changes so often, the influences of topography and riparian vegetation on shading varies. These observations would indicate that a project on one side of the river may contribute more heat to the river system than one located on the other side.

REFERENCES

Bartholow, J.M. 1989. Stream temperature investigations: field and analytic methods. Instream Flow Information Paper No. 13. U. S. Fish Wildl. Serv. Biol. Rep. 89 (17). 139 pp.

Burton, T.M., and G.E. Likens. 1973. The effect of strip-cutting on stream temperatures in the Hubbard Brook Experimental Forest, New Hampshire. Bioscience 23: 433-435.

Meehan, W.R. 1970. Some effects of shade cover on stream temperature in southeast Alaska. USDA For. Serv. Res. Note PNW-113. Pacific Northwest Forest and Range Experiment Station. 9 pp.

Moore, A.M. 1967. Correlation and analysis of water-temperature data for Oregon streams. U.S. Geological Survey Water-Supply Paper 1819-K. 53 pp.

Theurer, F.K., K.A. Voos, and W.J. Miller. 1984. Instream water temperature model. Instream Flow Information Paper 16. U.S. Fish Wildl. Serv. FWS/OBS-84/15. approx. 200 pp.

Table 1. Expected River Width Increases as a Result of Construction of all Proposed Feather Edge and Side-channel Projects on the Mainstem Trinity River, Trinity County, California.

Segment	Segment Length (m)	Comb. Proj. Length (m)	Percent Segment Affected	Avg Initial Width (m)	New Width (m)	Change (%)
1	1750	553	31.62	26.31	28.24	6.83
4	2500	396	15.86	26.31	27.28	3.56
5	2190	301	13.73	26.31	27.44	4.12
6	1580	704	44.54	26.31	29.98	12.24
8	1290	314	24.33	26.31	28.31	7.06
9	1060	494	46.60	34.02	36.86	7.70
10	2480	727	29.31	34.02	36.43	6.62
12	2280	423	18.55	34.02	35.55	4.30
15	670	657	98.13	34.02	41.48	17.98
17	1390	1748	125.74	34.02	44.37	23.33
18	4120	1427	34.64	34.02	36.56	6.95
19	2200	1578	71.71	34.02	39.92	14.78
21	2550	1480	58.05	34.46	39.24	12.18
22	4320	282	6.54	34.46	35.00	1.54
24	1330	1198	90.05	34.46	41.88	17.72
25	2890	1120	38.76	34.46	39.56	12.89
26	2220	1574	70.92	34.46	40.30	14.49
27	1710	1028	60.09	34.46	39.40	12.54
28	2170	1408	64.86	28.00	33.34	16.02
29	940	264	28.12	28.00	30.31	7.62
30	1610	1335	82.91	28.00	34.82	19.59
31	1610	306	18.98	28.00	29.56	5.28
32	940	1128	120.03	28.00	37.88	26.08
34	2670	486	18.19	28.00	29.50	5.08
35	810	540	66.69	28.00	33.50	16.42
36	3310	2029	61.29	28.00	33.05	15.28
Total		23500				

Table 2. Expected Changes in the Width to Discharge Relationship along the Trinity River as a Result of Construction of All Proposed Feather Edge and Side-channel Projects. Trinity County, California.

Segment	Proj. Length (m)	Segment Length (m)	Existing Segment Coef (A)	Existing Segment slope (B)	New Proj. Slope	New Segment Slope	Slope Change (%)
5	300	2190	21.59	0.0923	0.1080	0.0944	2.3
6	704	1580	21.59	0.0923	0.1080	0.0993	7.0
8	314	1290	21.59	0.0923	0.1080	0.0961	4.0
10	727	2480	29.55	0.0658	0.0770	0.0691	4.7
12	423	2280	29.55	0.0658	0.0770	0.0679	3.1
15	463	670	29.55	0.0658	0.0770	0.0735	10.5
17	1747	1390	29.55	0.0658	0.0770	0.0799	17.6
18	1143	4120	29.55	0.0658	0.0770	0.0680	3.3
19	1577	2200	32.12	0.0328	0.0384	0.0368	10.9
21	1481	2550	32.12	0.0328	0.0384	0.0360	9.0
22	282	4320	32.12	0.0328	0.0384	0.0332	1.1
24	1198	1330	32.12	0.0328	0.0384	0.0378	13.3
25	1792	2890	32.12	0.0328	0.0384	0.0363	9.5
26	1574	2220	32.12	0.0328	0.0384	0.0368	10.8
27	1027	1710	32.12	0.0328	0.0384	0.0361	9.3
28	1407	2170	32.12	0.0328	0.0384	0.0364	9.9
29	264	940	32.12	0.0328	0.0384	0.0344	4.6
30	1334	1610	18.49	0.1939	0.2269	0.2212	12.3
31	305	1610	18.49	0.1939	0.2269	0.2001	3.1
32	1128	940	18.49	0.1939	0.2269	0.2335	16.9
34	486	2670	18.49	0.1939	0.2269	0.1999	3.0
35	541	810	18.49	0.1939	0.2269	0.2159	10.2
36	2029	3310	18.49	0.1939	0.2269	0.2141	9.4
						Max	17.6
						Min	1.1

Table 3. Expected Losses of Shading Density along East and West Sides of the Trinity River as a Result of Construction of All Proposed Feather Edge Projects, Trinity County, California.

Segment	East or West	Existing Maximum Shading Density	Post-Project Maximum Shading Density	Shading Loss (%)
6	E	0.53	0.36	32.72
12	E	0.80	0.65	18.55
15	E	0.43.	0.13	69.10
17	E	0.81	0.60	26.04
18	E	0.80	0.70	12.06
19	E	0.70	0.53	23.91
21	E	0.74	0.45	39.84
22	E	0.51	0.48	6.53
24	E	0.54	0.33	39.40
25	E	0.56	0.43	23.25
26	E	0.53	0.28	46.98
27	E	0.54	0.38	30.29
28	E	0.53	0.37	30.65
29	E	0.53	0.38	28.09
30	E	0.53	0.43	19.01
32	E	0.35	0.10	71.38
34	E	0.62	0.54	13.60
36	E	0.62	0.55	11.48
Max				71.38
Min				6.53
5	W	0.79	0.68	13.70
6	W	0.64	0.56	11.84
8	W	0.81	0.61	24.34
10	W	0.54	0.38	29.31
17	W	0.79	0.00	99.64
18	W	0.79	0.73	7.86
19	W	0.79	0.41	47.77
21	W	0.82	0.67	18.24
24	W	0.54	0.27	50.68
25	W	0.64	0.39	38.75
26	W	0.56	0.43	23.92
27	W	0.64	0.45	29.77
28	W	0.63	0.41	34.19
30	W	0.53	0.19	63.85
31	W	0.70	0.57	18.94
32	W	0.35	0.18	48.62
34	W	0.58	0.55	4.61
35	W	0.51	0.17	66.79
36	W	0.63	0.32	49.82
Max				99.64
Min				4.61

Table 4a.

Baseline Conditions of the Water Temperatures of the Trinity River at Douglas City (RM 94), as Predicted by SNTEMP.				
Date	Lewiston Dam Release Temperature (C) (Q = 300 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	12.53	12.10	10.76
Dec 31	6.0	5.84	5.32	5.84
Apr 1	7.0	10.03	9.13	8.73
Jul 1	10.0	16.14	15.05	14.03

Table 4b.

Water Temperatures of the Trinity River at Douglas City (RM 94), as Predicted by SNTEMP, with Construction of all Proposed Feather Edge and Side-Channel Projects.				
Date	Lewiston Dam Release Temperature (C) (Q = 300 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	12.62	12.19	10.82
Dec 31	6.0	5.85	5.32	5.84
Apr 1	7.0	10.08	9.16	8.74
Jul 1	10.0	16.30	15.18	14.13

Table 4c.

Differences in the Water Temperatures of the Trinity River at Douglas City (RM 94), as Predicted by SNTEMP, of before and after Construction of Proposed Feather Edge and Side-Channel Projects.				
Date	Lewiston Dam Release Temperature (C) (Q = 300 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	0.09	0.09	0.06
Dec 31	6.0	0.01	0.00	0.00
Apr 1	7.0	0.05	0.03	0.01
Jul 1	10.0	0.16	0.13	0.10

Table 6a.

Baseline Conditions of the Water Temperatures of the Trinity River at the Trinity Canyon Lodge (RM 74), as Predicted by SNTEMP.				
Date	Lewiston Dam Release Temperature (C) (Q = 300 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	14.59	13.67	11.11
Dec 31	6.0	5.59	4.50	4.56
Apr 1	7.0	10.67	8.89	7.76
Jul 1	10.0	19.88	17.29	15.09

Table 6b.

Water Temperatures of the Trinity River at the Trinity Canyon Lodge (RM 74), as Predicted by SNTEMP, with Construction of all Proposed Feather Edge and Side-Channel Projects.				
Date	Lewiston Dam Release Temperature (C) (Q = 300 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	14.77	13.84	11.21
Dec 31	6.0	5.60	4.51	4.56
Apr 1	7.0	10.76	8.95	7.78
Jul 1	10.0	20.18	17.54	15.27

Table 6c.

Differences in the Water Temperatures of the Trinity River at the Trinity Canyon Lodge (RM 74), as Predicted by SNTEMP, of before and after Construction of Proposed Feather Edge and Side-Channel Projects.				
Date	Lewiston Dam Release Temperature (C) (Q = 300 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	0.18	0.17	0.10
Dec 31	6.0	0.01	0.01	0.00
Apr 1	7.0	0.09	0.06	0.02
Jul 1	10.0	0.30	0.25	0.18

Table 5a.

Baseline Conditions of the Water Temperatures of the Trinity River at Douglas City (RM 94), as Predicted by SNTEMP.				
Date	Lewiston Dam Release Temperature (C) (Q = 800 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	11.25	11.08	10.45
Dec 31	6.0	6.00	5.65	5.88
Apr 1	7.0	8.85	8.46	8.38
Jul 1	10.0	13.12	12.79	12.45

Table 5b.

Water Temperatures of the Trinity River at Douglas City (RM 94), as Predicted by SNTEMP, with Construction of all Proposed Feather Edge and Side-Channel Projects.				
Date	Lewiston Dam Release Temperature (C) (Q = 800 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	11.29	11.12	10.49
Dec 31	6.0	6.00	5.65	5.88
Apr 1	7.0	8.88	8.49	8.39
Jul 1	10.0	13.20	12.87	12.51

Table 5c.

Differences in the Water Temperatures of the Trinity River at Douglas City (RM 94), as Predicted by SNTEMP, of before and after Construction of Proposed Feather Edge and Side-Channel Projects.				
Date	Lewiston Dam Release Temperature (C) (Q = 800 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	0.04	0.04	0.04
Dec 31	6.0	0.00	0.00	0.00
Apr 1	7.0	0.03	0.03	0.01
Jul 1	10.0	0.08	0.08	0.06

Table 7a.

Baseline Conditions of the Water Temperatures of the Trinity River at the Trinity Canyon Lodge (RM 74), as Predicted by SNTEMP.

Date	Lewiston Dam Release Temperature (C) (Q = 800 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	12.58	12.17	10.81
Dec 31	6.0	5.91	5.06	4.76
Apr 1	7.0	9.75	8.59	7.72
Jul 1	10.0	15.98	14.89	13.76

Table 7b.

Water Temperatures of the Trinity River at the Trinity Canyon Lodge (RM 74), as Predicted by SNTEMP, with Construction of all Proposed Feather Edge and Side-Channel Projects.

Date	Lewiston Dam Release Temperature (C) (Q = 800 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	12.69	12.27	10.88
Dec 31	6.0	5.92	5.06	4.75
Apr 1	7.0	9.82	8.64	7.74
Jul 1	10.0	16.19	17.07	13.90

Table 7c.

Differences in the Water Temperatures of the Trinity River at the Trinity Canyon Lodge (RM 74), as Predicted by SNTEMP, of before and after Construction of Proposed Feather Edge and Side-Channel Projects.

Date	Lewiston Dam Release Temperature (C) (Q = 800 cfs)	Hypothetical Year Type		
		Hot-Dry	Median	Cold-Wet
Oct 1	10.0	0.11	0.10	0.07
Dec 31	6.0	0.01	0.00	-.01
Apr 1	7.0	0.07	0.05	0.02
Jul 1	10.0	0.21	0.18	0.14